5.3.2 Bansbari project

(1) Outline

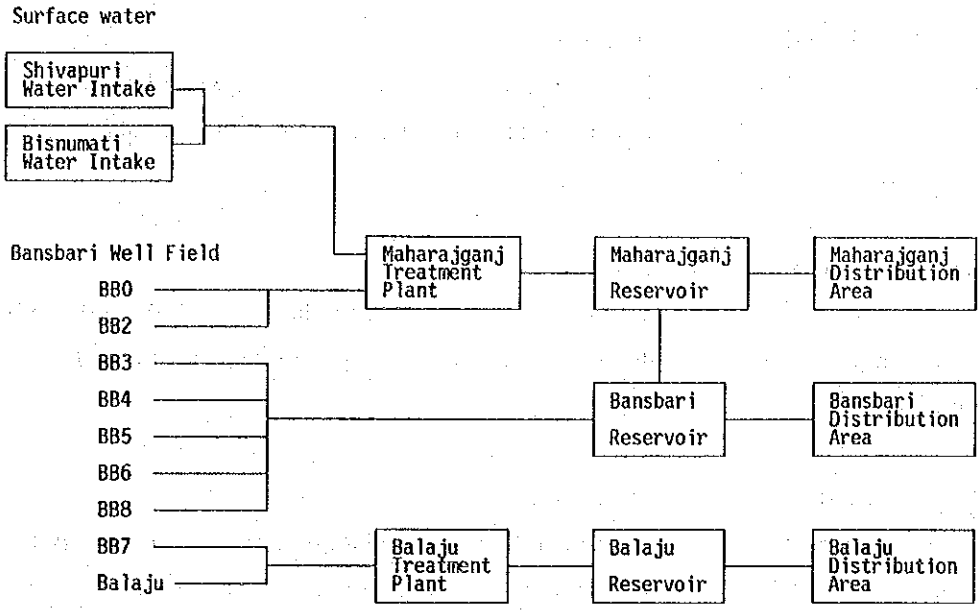
A treatment plant with a maximum water supply capacity of 22,100 m^3/d, (including expansion of the existing surface water intakes and water conveyance facilities), should be constructed in the existing Bansbari reservoir by the conjunctive use of the surface water from the intakes to be expanded and improved and the existing ground water.

Out of the treated water 6,800 m^3/d should be supplied from the existing Bansbari reservoir (capacity of 2,000 m^3) to the northern distribution area of Kathmandu city by gravity flow, and the remaining 15,300 m^3/d be transmitted to the Maharajganj reservoir and supplied to the central distribution area of Kathmandu city.

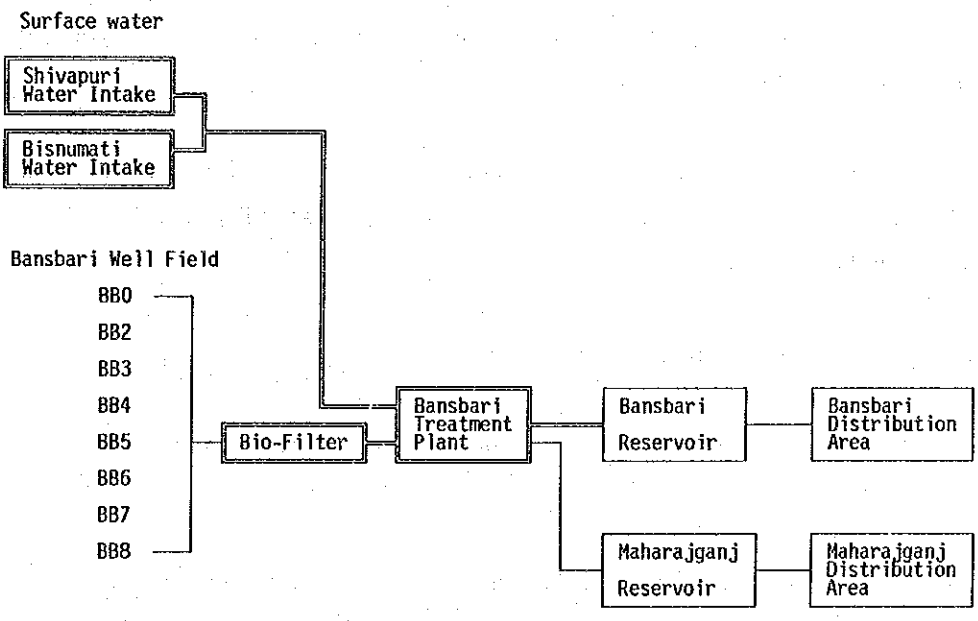
The water supply amount of the existing water supply system was 11,344 m^3/d in 1989, 10,692 m^3/d in 1991, and the maximum water supply capacity will be 22,100 m^3/d after completing this Project.

The present and planned water supply system diagrams are shown as follows:

Present System



Planned System




: Facilities covered by the Project

(2) Water intake facilities

1) Shivapuri water intake

The existing Shivapuri intake should be expanded and improved so that it can intake 14,000 m^3/d in the wet season and 3,700 m^3/d in the dry season.

2) Bisnumati water intake

The existing Bisnumati intake should be expanded and improved so that it can intake 7,000 m^3/d in the wet season and 1,800 m^3/d in the dry season.

3) Existing groundwater source

Water should be taken in at a maximum rate of 17,600 m^3/d (annual average of 5,810 m^3/d) from the Bansbari well field (8 wells). Although the abstraction from the these well field was 16,480 m^3/d in March 1991, the rate of inflow to the Bansbari reservoir is estimated to be 14,200 m^3/d according to the results of analysis of the operation records because of the water consumption of inhabitants living along the conveyance piping and loss due to leakage.

Accordingly, it is necessary that a maximum pumping capacity of 20,400 m^3/d should be secured by promptly executing the well improvement plan by the UWSSRP.

(3) Water conveyance facilities

1) Water conveyance facilities for groundwater source

Use of the existing piping.

2) Water conveyance facilities for surface water source

a) Conveyance pipeline from the Shivapuri intake to Burhanilkanth

Conveyance capacity:	14,000 m^3/d
Total length:	2,019 m
Difference in elevation:	218 m
	(EL 1,651 m to EL 1,433 m)

Pipe diameter:	ϕ250 mm
Material:	VP pipe
Pressure reducing valve:	ϕ250 x 3 places
Air valve:	at 5 places

b) Conveyance pipeline from the Bisnumati intake to Burhanilkanth

Conveyance capacity:	7,000 m^3/d
Total length:	1,433 m
Difference in elevation:	55 m (EL 1,488 m to EL 1,433 m)
Pipe diameter:	ϕ200 mm
Material:	VP pipe
Pressure reducing valve:	ϕ200 x 1 place
Air valve:	at 4 places
Drainage:	at 1 places

c) Conveyance pipeline from Burhanilkanth to the Bansbari treatment plant

Conveyance capacity:	21,000 m^3/d
Total length:	3,826 m
Difference in elevation:	70 m (EL 1,433 m to EL 1,363 m)
Pipe diameter:	ϕ350 mm
Material:	VP pipe
Pressure reducing valve:	ϕ350 mm x 1 place
Air valve:	at 3 places
Drainage:	at 2 places

(4) Treatment facilities

Both groundwater and surface water should be treated in the treatment plant. The monthly treatment amount for each unit process is shown in Table 5.3.4. The treatment capacity of each unit process should meet these treatment amounts. The capacity of the bio-filter should be 17,600 m^3/d. The capacity of the coagulo-sedimentation basin and rapid sand filter should be such that the following two cases can be treated at the same time.

Table 5.3.4 MONTHLY TREATMENT AMOUNT OF UNIT PROCESS
(Bansbari Treatment Plant)

(Unit: m^3/d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Groundwater												
Bio-filtration	-	5,200	12,200	17,000	17,600	17,300	-	-	-	-	-	-
Coagulo-sedimentation	-	5,000	12,800	16,600	17,300	16,900	-	-	-	-	-	-
Filtration for iron removal	-	5,000	12,800	16,600	17,300	16,900	-	-	-	-	-	-
Surface water												
Coagulo-sedimentation	5,500	5,500	5,500	5,500	5,500	5,500	21,000	21,000	21,000	19,400	17,700	15,200
Rapid sand filtration	5,500	5,500	5,500	5,500	5,500	5,500	21,000	21,000	21,000	19,400	17,700	15,200

(Unit: m^3/d)

	Case 1 (June)	Case 2 (July)
Groundwater	17,300	0
Surface water	5,500	21,000

1) Bio-filter

a) Treatment capacity: 17,600 m^3/d
b) Number of basins: 10 basins
c) Filtration area per basin:
14.7 m^2 (2.46 m x 5.98 m)
d) Filtration rate: 120 m/d (normal)
133 m/d (maximum)
e) Filter layer: pumice (grain size: 8 to 12 mm, layer depth: 1.3 m)
f) Supporting layer: Gravel (grain size: 10 to 30 mm, layer thickness: 0.3 m)
g) Water collection device:
water collection device for air washing
h) Raw water distribution device:
0.9 m wide rectangular weir,
ϕ300 mm soft seal valve.
i) Drain device: water discharge trough: 300 x 300 x 2,700 x 4 pieces/basin
water discharge gate: 450 mm square
j) Washing: clear water gate: 500 mm square
backwashing rate: 1.0 $m^3/m^2/min$
backwashing time: 8 min
air washing rate: 0.8 $m^3/m^2/min$
air washing time: 6 min
k) Replenishment water equipment:
replenishment water pump (This should also be used for the rapid sand filter.)

1) Blower unit: ratio of treatment amount/air blowing amount = 1/2.
blower: 13.2 m^3/min x 6 mAg x 30 KW x 3 units

2) Water receiving well and mixing basin

a) Number of basins: 2 basins
b) Capacity per basin: 53 m^3
c) Detention time: approx. 3.6 min
d) Mixing method: fall gravity type

3) Flocculation basin

The capacity is to be studied for the above-mentioned two cases.

	Groundwater	Surface water	Total
Case 1	$\frac{17,300}{24 \times 2} = 360$	$\frac{5,500}{24 \times 2} = 115$	475 m^3
Case 2	$\frac{0}{24 \times 2} = 0$	$\frac{21,400}{24 \times 2} = 438$	438 m^3

a) Capacity per basin: 117 m^3 (1.15 m wide x 3.15 m deep x 8.1 m long x 4 rows)
b) Number of basins: 4 basins
c) Detention time: 30 min
d) Type of flocculation:
vertical baffling type
lower bent: 5, overflow weir: 4
G value: 66 to 15 sec^{-1}
total head loss: 260 mm

4) Sedimentation basin

The capacity is studied for the above-mentioned two cases.

	Groundwater	Surface water	Total
Case 1	$\frac{17,300}{24} = 721$	$\frac{5,500}{24/3} = 688$	1,409 m^3
Case 2	$\frac{0}{24} = 0$	$\frac{21,000}{24/3} = 2,625$	2,625 m^3

a) Capacity per basin: 660 m^3 (5.2 m wide x 3.0 m deep x 42.3 m long)

b) Number of basins: 4 basins

c) Detention time: (surface water): 3 hr
(groundwater): 1 hr and 52 min

d) Flow rate: (surface water): 23.4 cm/min
(groundwater): 37.6 cm/min

e) Sludge removal equipment:
drain pit: capacity: 4.4 m^3
number of pits: 40 pits
sludge valve: 20 places (Sludge shall be discharged using one discharge valve of ϕ250 mm for two pits.)

5) Rapid sand filter and filter for iron removal

The filtration area is decided for the above-mentioned two cases.

	Groundwater	Surface water
Case 1	$\frac{17,300}{300} = 57.7\ m^2$	$\frac{5,500}{150} = 36.7\ m^2$
Case 2	$\frac{0}{300} = 0\ m^2$	$\frac{21,000}{150} = 140.0\ m^2$

a) Filtration area per basin:
20.0 m^2

b) Number of basins: 8 basins

c) Filtration rate: maximum:
(surface water): 150 m/d
(groundwater): 282 m/d
normal:
(surface water): 131 m/d
(groundwater): 211 m/d

d) Filter layer: sand (effective diameter: 0.6 mm, uniformity coefficient: less than 1.8)
layer thickness: 0.6 m

e) Supporting layer: gravel (2 to 20 mm)
layer thickness: 0.2 m

f) Water collecting device:
self washing porous blocks

g) Raw water distribution device:
0.9 m wide rectangular weir,
ϕ300 mm soft seal valve.

h) Drain device:
water discharge trough: 300 x 300 x 2,900 x 4 pieces/basin
water discharge gate: 450 mm square

i) Backwashing: backwashing rate: 0.6 $m^3/m^2/min$ x 8 min
backwashing flow rate: 20 m^2/basin x 0.6 $m^3/m^2/min$ = 12 m^3/min, 12 m^3/min x 8 min = 96 m^3
replenishment water flow rate: maximum 8 m^3/min
replenishment water pump: 4 m^3/min x 7 m x 7.5 KW x 2 units, 4 m^3/min x 25 m x 30 KW x 1 unit (This should also be used as the surface washing pump.)
replenishment water pipe: ϕ200 to ϕ300 mm

j) Surface washing: surface washing rate: 0.2 $m^3/m^2/min$ x 5 min
surface washing valve: ϕ250 mm soft seal valve
surface washing pump: 4 m^3/min x 25 m x 30 KW x 2 units
fixed-type surface washing device
surface washing pipe: ϕ250 mm

k) Clear water equipment:
Clear water gate: 450 mm square

l) Filtration control weir:
1.5 m wide rectangular weir x 9 units

6) Clear water reservoir (This should also be used as the transmission pump pit.)

a) Number of basins: 2 basins
b) Capacity of one basin:
465 m^3
c) Detention time: 1 hr
d) Inflow gate: 400 mm square x 2 units
e) Outflow gate: 400 mm square x 2 units

7) Water transmission facilities (to the Bansbari reservoir)

a) Transmission pump: 2.7 m^3/min x 7 m x 5.5 KW x 3 units (including one spare pump)
b) Transmission pipe: ϕ300 mm x 80 m

8) Coagulant dissolution and feeding equipment

a) Coagulant: poly aluminum chloride (PAC)
effective Al_2O_3: 30%

PAC, with 30% effective Al_2O_3, should be used after it is dissolved to make a 5% Al_2O_3 solution. The feeding rate should be as follows:

Feeding ratio: $P = 8.7 + 2.2\sqrt{T}$ (T: turbidity of raw water)

b) Dissolution tank: 0.4 m^3 x 2 tanks (with inverting type agitator)

c) Average feeding rate:

surface water (wet season)

22.2 mg/l (5% solution), 3.7 mg/l (30% PAC)

surface water (dry season)

15.6 mg/l (5% solution), 2.6 mg/l (30% PAC)

groundwater

15.6 mg/l (5% solution), 2.6 mg/l (30% PAC)

Maximum feeding rate:

40.0 mg/l (5% solution), 6.7 mg/l (30% PAC)

d) Solution storage tank:

1 m^3 x 2 tanks

e) Transfer pump: 30 l/min x 2 units

f) Constant flow rate control apparatus:

2 units (constant flow rate control valve, feeding pump, constant volume tank)

9) Alkali dissolution and feeding equipment (for biological filtration)

a) Alkali agent: solid sodium hydroxide

(This should be used after dissolving solid sodium hydroxide to make a 10% solution.)

b) Average feeding rate:

20 mg/l (For adjusting pH of filtered water around 7.2 to 7.6.)

c) Dissolution tank: 0.4 m^3 x 2 tanks (with inverting type agitator)

d) Transfer pump: 30 l/min x 2 units

e) Solution storage tank:

1.5 m^3 x 2 tanks

f) Constant flow rate control apparatus:

1 unit (constant flow rate control valve, feeding pump, constant volume tank)

10) Alkali dissolution and feeding equipment (for surface water)

a) Alkali agent: solid calcium hydroxide

b) Average feeding rate:

wet season: 16/0.8 = 20 mg/l (as $CaCO_3$)

dry season: 4/0.8 = 5 mg/l (as $CaCO_3$)

(This should be used after dissolving calcium hydroxide, $Ca(OH)_2$, to make a 20% solution in terms of $CaCO_3$.)

c) Dissolution tank: 0.4 m^3 x 2 tanks

(with inverting type agitator)

d) Transfer pump: sludge pump, 30 l/min x 2 units

e) Solution storage tank:

1 m^3 x 2 tanks

f) Constant flow rate control apparatus:

1 unit (constant flow rate control valve, feeding pump, constant volume tank)

11) Sterilization equipment

a) Sterilization agent:

bleaching powder (This should be used after bleaching powder with effective chlorine of 15% is dissolved to make a 5% solution.)

b) Average feeding rate:

surface water (wet season)	2.5 mg/l
surface water (dry season)	1.5 mg/l
groundwater	2.1 mg/l

c) Dissolution tank: 0.4 m^3 x 2 units

(with inverting type agitator)

d) Transfer pump: 30 l/min x 2 units

e) Solution storage tank:

1 m^3 x 2 tanks

f) Constant flow rate control apparatus:

2 units (constant flow rate control valve, feeding pump, and constant volume tank)

12) Sludge and drainage basin

a) Number of basins: 2 basins
b) Capacity per basin: 256 m^3
c) Sludge and drainage pump:
2 m^3/min x 12 m x 11 KW x 3 units
d) Drain pipe: VU pipe, ϕ200 x 150 m

13) Electrical installations

a) Power incoming equipment

Electric power should be supplied from the existing line in the Shoe factory to the treatment plant through buried wiring.

Lead-in power: 3 phases x 3 lines, 11 KV, 50 Hz
Buried wiring: 300 m

b) Incoming/transforming system

Incoming: 3 phases x 4 lines, 11 KV, 50 Hz
Primary voltage: 3 phases x 4 lines, 11 KV, 50 Hz
Secondary voltage:
3 phases x 4 lines, 400 V - 230 V, 50 Hz
Transformer: 500 KVA (11 KV/400 V - 200 V) x 1 unit
Type of power distribution panel:
indoor closed-type distribution panel

c) Independent power generation

Generator: 3 phases x 4 lines (400 V/230 V) diesel generator
Output: 300 KVA x 1 unit
Type of cooling: radiator cooling
Fuel: heavy oil or light oil
Operation: manual operation in case of power failure

d) Trunk line system

Wiring and piping work should be carried out from the secondary side of the low voltage power distribution panel in the power room to the primary side of the power control panel and distribution panel.

e) Power control system

Wiring and piping work should be carried out from the secondary side of the power control panel to each power unit in the treatment plant in order to supply electric power, and power control panels should be installed.

Distribution voltage:

3 phases x 3 lines, 400 V

Load: Refer to Table 5.3.5.

f) Lighting and outlets

Wiring and piping work and the installation of equipment should be carried out from the secondary side of a power distribution panel to the lighting and outlets in a building in the treatment plant in order to supply electric power, and outdoor lighting facilities for the security of the plant should be installed.

Distribution voltage:

3 phase x 4 lines	230 V
1 phase x 2 lines	230 V

g) Instrumentation

Instruments of the plant should be installed and wiring and piping for the instruments should be provided.

Water quality instruments:

Turbidimeter: (2 sets for raw water and 1 set for treated water)

pH meter:	(2 sets for raw water and 1 set for treated water)
Residual chlorine meter:	1 set
Flow meter:	for ϕ500 2 sets
	for ϕ450 2 sets
	for ϕ400 1 set

Table 5.3.5 LOAD LIST OF BANSBARI TREATMENT PLANT

Equipment	Load Capacity (kW)	Fix (Unit)	Spare (Unit)	Non-Fix (Unit)	Total Load (kW)
Bio-Filter					
Blower	30.0	2	1	0	60.0
Rapid Sand Filter					
Surface washing pump	30.0	1	2	0	30.0
Make-up pump	7.5	2	0	0	15.0
Transmission pump	5.5	2	1	0	11.0
Aluminum Sulfate Feeding Facility					
Dissolution-mixer	2.2	2	0	0	4.4
Reception pump	0.4	1	1	0	0.4
Injection pump (for surface water)	0.2	2	1	0	0.4
Injection pump (for groundwater)	0.2	1	1	0	0.2
Alkali Agent (Lime) Feeding Facility					
Dissolution-mixer	2.2	2	0	0	4.4
Reception pump	3.7	1	1	0	3.7
Mixer	0.4	2	0	0	0.8
Injection pump	0.2	4	0	0	0.8
Alkali Agent (NaOH) Feeding Facility					
Dissolution-mixer	2.2	2	0	0	4.4
Reception pump	0.4	1	1	0	0.4
Injection pump	0.2	2	1	0	0.4
Sodium Hypochlorite Generator					
Salt water pump	0.4	0	0	2	0
Clear water pump	0.4	0	0	2	0
Electrolysis	17.0	0	0	2	0
Injection pump	0.4	2	0	0	0.8
Bleaching Powder Feeding Facility					
Dissolution-mixer	2.2	2	0	0	4.4
Reception pump	0.4	1	1	0	0.4
Injection pump	0.2	4	1	0	0.8
Waste water pump	11.0	2	1	0	22.0
Total					164.7